Progress Report

June 10, 2015

Steam Enhanced Extraction at the Former Williams AFB, ST012 Site

Mesa, AZ

1. Summary

This report covers the period of operations from Tuesday, June 2, 2015 through Monday, June 8, 2015. The following table provides a summary of the project operational status.

Table 1. Project Summary

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft^2)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	06/08/15	
Last Temperature Data Update	06/08/15	
Estimated Total Days of Operation	422	days
Days of Operation	252	days
Days of Operation vs. Estimate	60	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	2,246,633	kWh
Used Electrical Energy vs. Estimate	20	%
Total Steam Injected	150.5	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	47	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	286,244	lbs
Total Mass Removed as NAPL	703,580	lbs
Average Daily NAPL Mass Removal Last Week	5,383	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	989,823	lbs
Average Power Usage Rate Last Week	469	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last Week	410	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	0.5	gallons per minute (gpm)
Average Water Extraction Rate Last Week	100	gpm
Total Water Extracted	38,441,841	gallons
Total Recovered Light Non-Aqueous Phase Liquid	106,927	gallons
Average Water Discharge Rate Last Week	148	gpm
Total Treated Water Discharge	49,512,000	gallons

Operational highlights from the past week include:

- The TMP 17 repair was completed with the new monitoring array set at a bottom depth of 194 ft bgs due to obstructions experienced during installation. TMP 01 was identified as compromised during this operational period and the sensor array was removed from the well. The project team is continuing to watch TMP 04.
- On June 8, 2015 the first steam pressurization cycle was initiated in the northern part of the UWBZ by dialing the injection rates back at steam injection wells SIW UWBZ 3, 7, 9, 11, 12, 14 and 25.

- Additionally, on June 8, 2015 Boiler 1 was brought offline to repair a leaking gasket. The steam injection rates in the LSZ were also reduced to accommodate the reduced steam output.
- The average steam injection rate in the LSZ was 24,000 lbs/hr (or 48 gpm).
- The average steam injection rate in the UWBZ was 11,400 lbs/hr (or 22.8 gpm).
- Beginning on May 26, 2015, six eductor skids were operated. The average liquid extraction rate from the formation was approximately 100 gpm. TerraTherm is currently troubleshooting the eductor wells to increase the extraction rate.
- The average steam injection rate last week was 70.8 gpm. The net extraction from the formation was ~41% due to the extraction issues encountered; however, by the end of the reporting period (June 8, 2015) the steam injection rate was 28,200 lbs/hr (56.4 gpm) while the liquid extraction was kept at 99 gpm, corresponding to a net extraction of 75%.
- Collected process, wellfield and laboratory data per the sampling schedule.
- Conducted regular maintenance on the treatment system.

2. Vapor Extraction

Figure 1 below shows the vapor extraction rate from the site. Note that the estimated steam extraction rate is a calculated value based on the water generated at the moisture separators after cooling the vapors from the wellfield. Additionally the wellfield flow is calculated as the difference between the air stripper flows and thermal accelerator influent, and is therefore only an estimate.

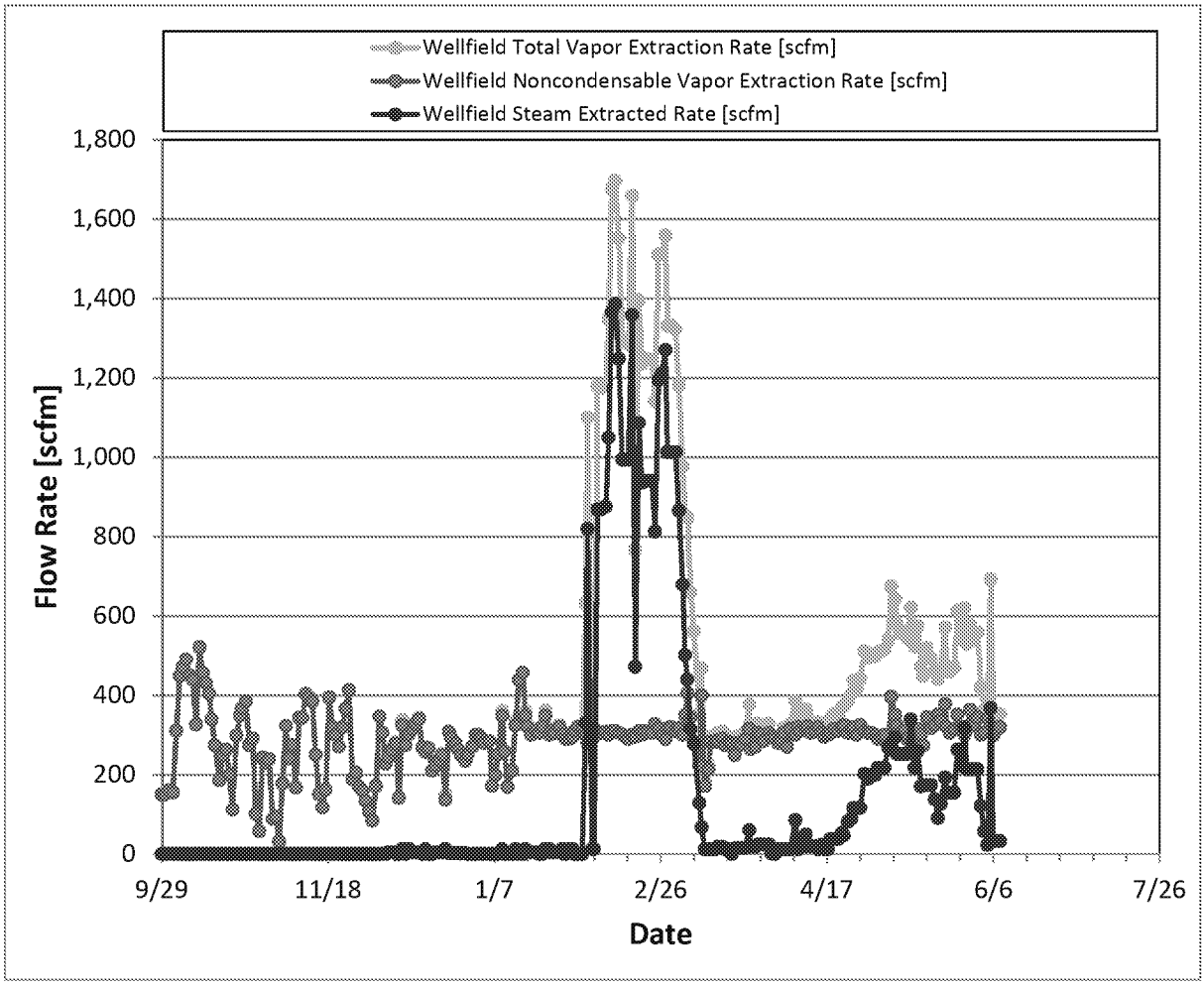

Figure 1. Vapor Extraction Rate

Note: Well SVE01M was tied into the SEE extraction system on June 5, 2015.

3. PID Measurements

The following figure depicts the PID concentrations from the wellfield effluent to the effluent of the thermal accelerators collected since the start of operations. Note that PID readings of 0.0 parts per million by volume (ppmV) are shown in the figures as 0.01 ppmV due to the logarithmic scale that does not allow display of 0-values. Accelerator influent readings are interpolated for days where no data is collected, since the value is used in the mass removal calculation.

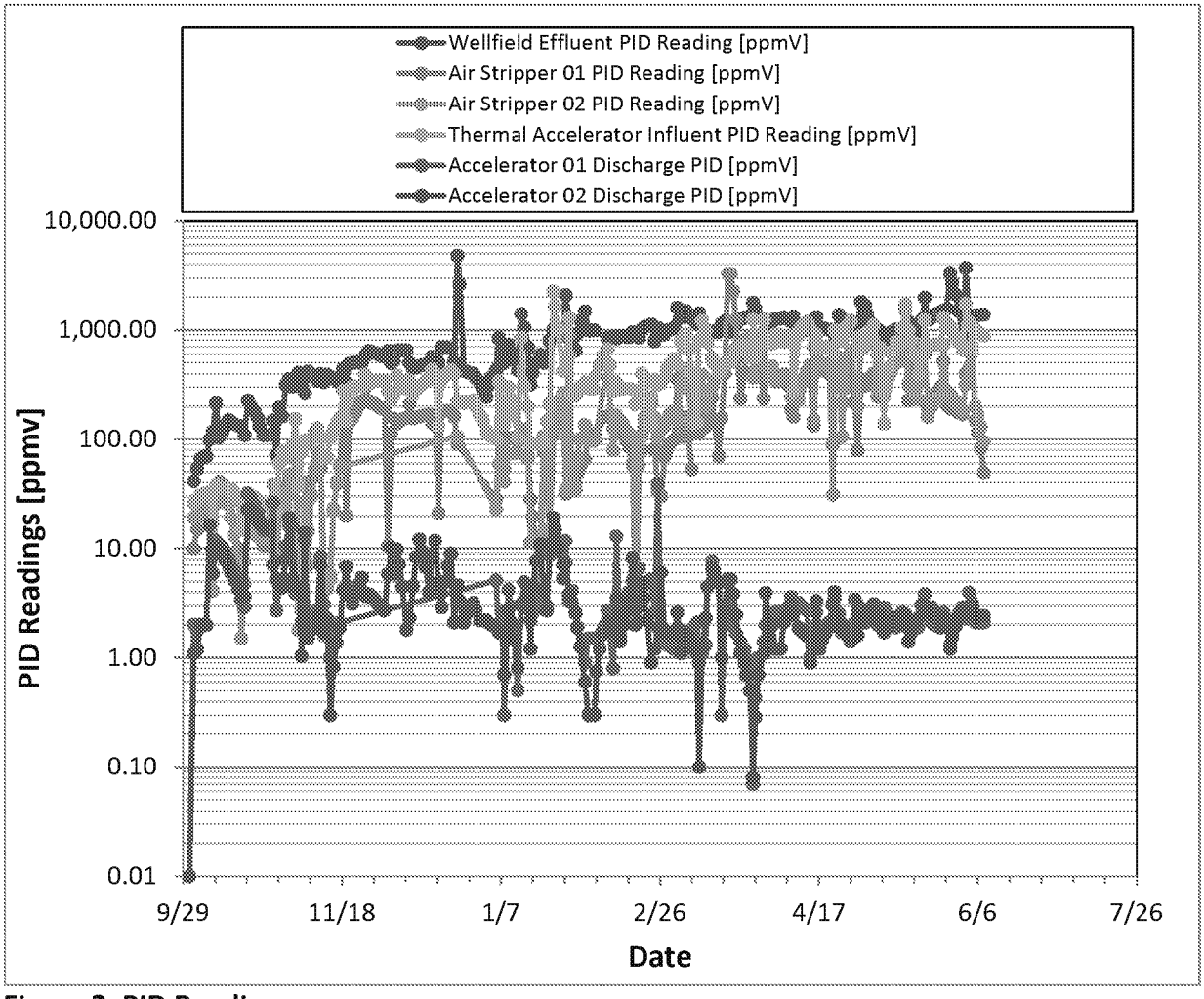

Figure 2. PID Readings

4. Mass Removal

The mass removal is calculated based on the PID and laboratory data collected at the thermal accelerator influent and the LNAPL recovered. The figure also depicts the mass removed based on PID and laboratory data.

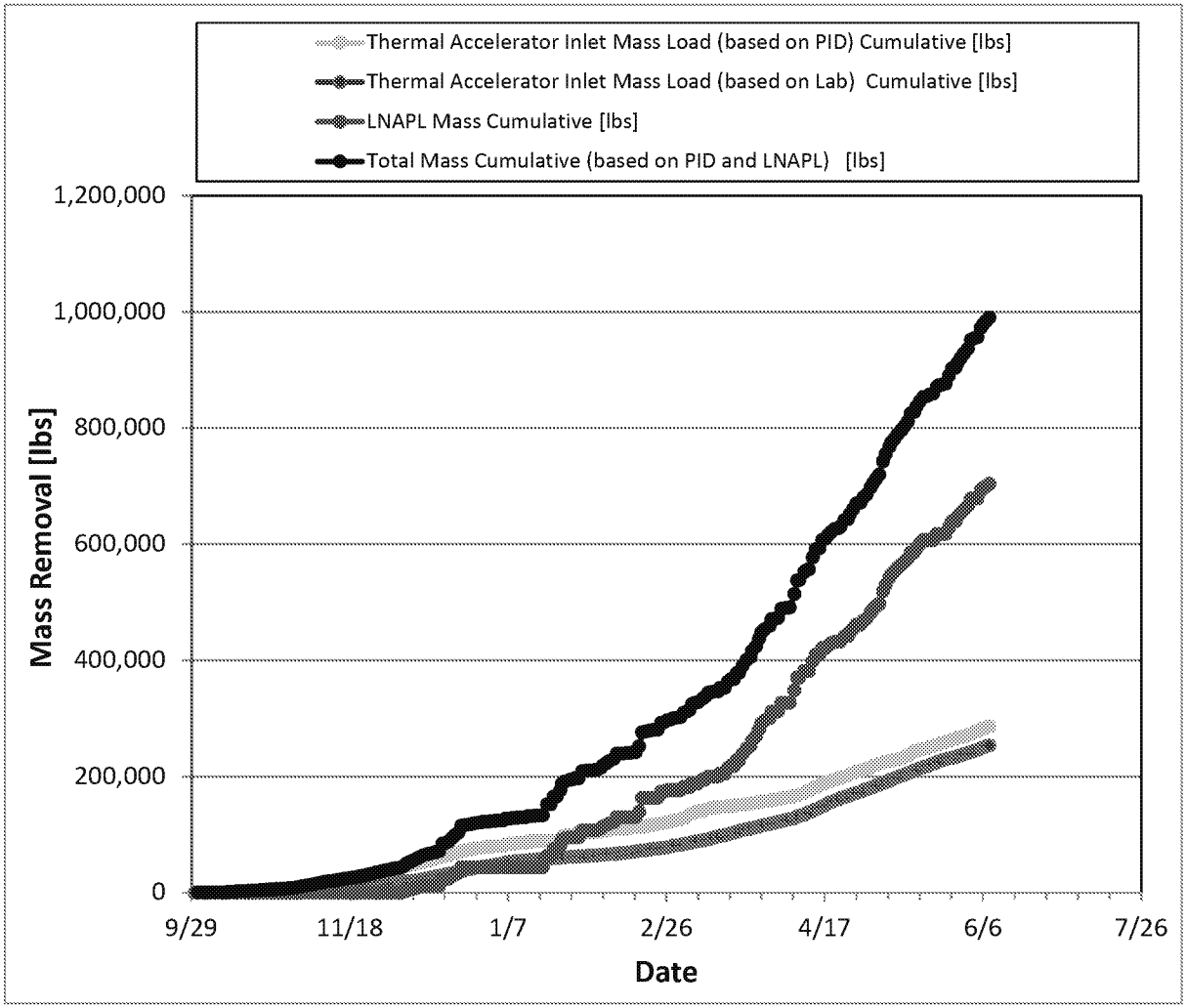

Figure 3. Mass Removal

Note: A NAPL density of 6.58 lbs/gallons was used to convert the NAPL volume to pounds.

5. Daily Mass Removed

Figure 4 outlines the daily mass removed as vapor and LNAPL. The total daily mass removed is the combination of vapor and LNAPL. The liquid mass removal is captured in the vapor phase due to the volatilization of liquid contaminants in the air strippers.

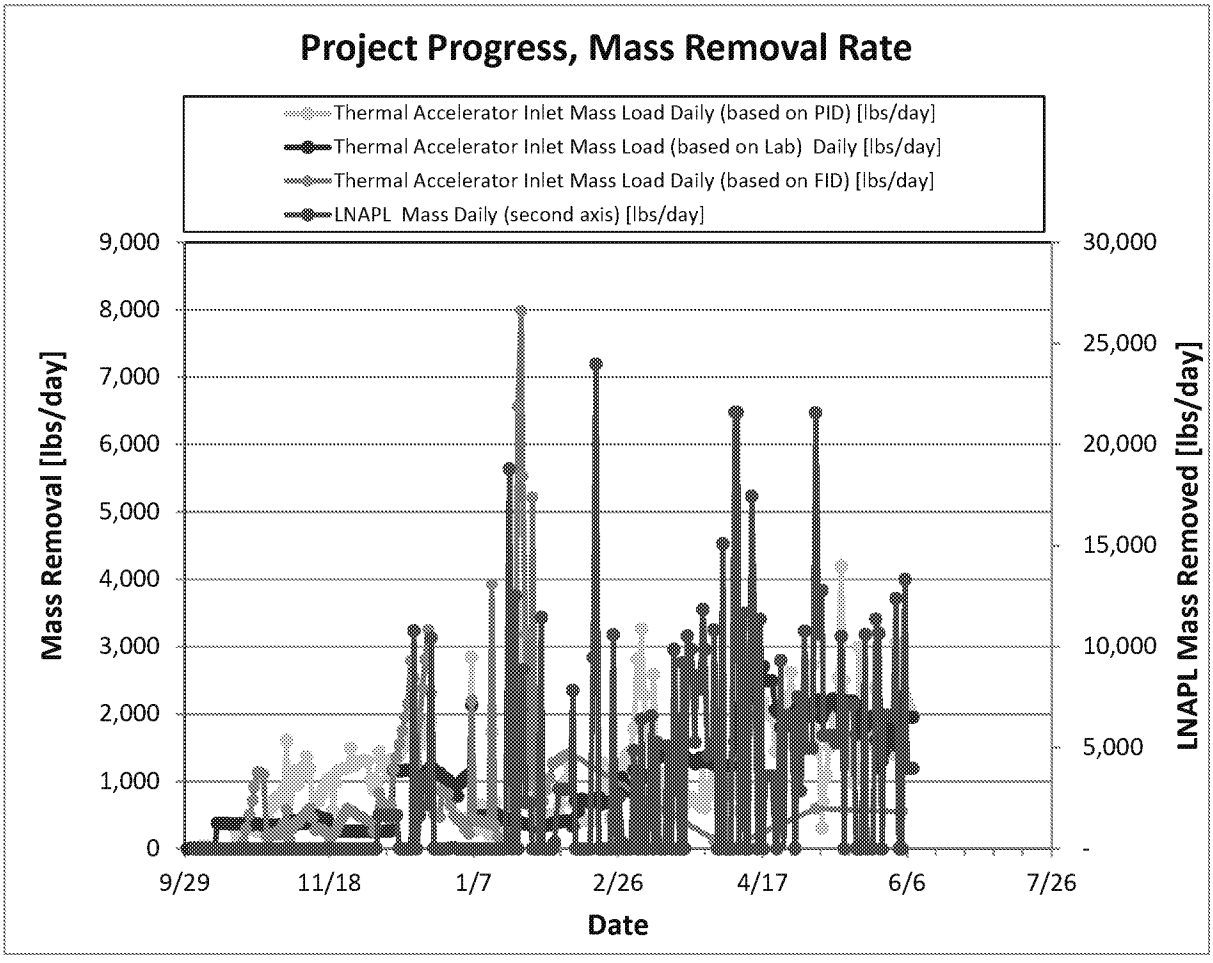

Figure 4. Daily Mass Removed

Note: Laboratory data are not collected daily. The "Thermal Accelerator Inlet Mass Load (based on lab)" is an average daily rate of actual lab data collected. Note that accumulated LNAPL is pumped through the NAPL conditioning system in a batch style process.

6. Power Usage

The cumulative power usage is shown below. All electricity used at the site is utilized to run the process system and steam generators.

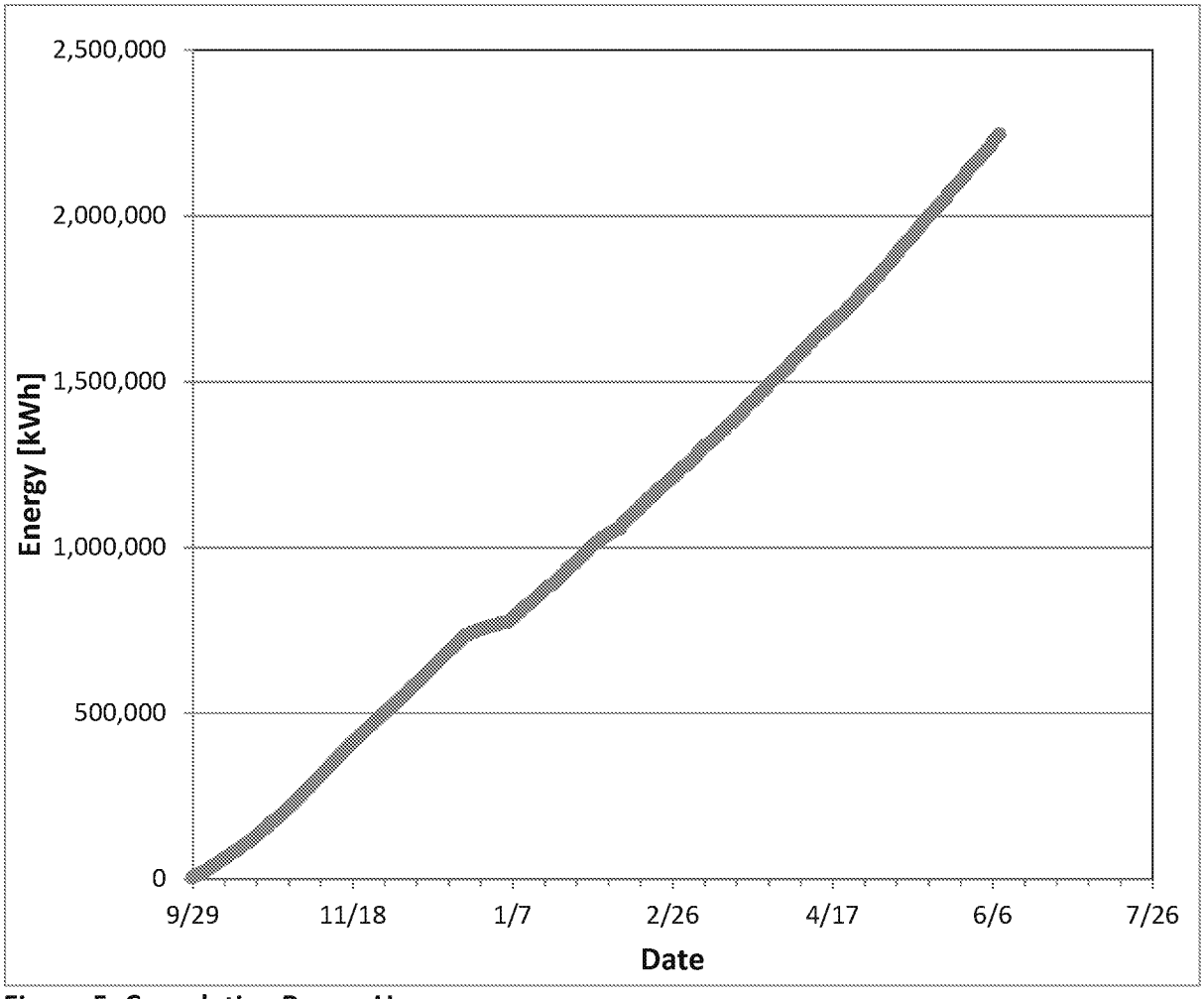

Figure 5. Cumulative Power Usage

7. Average Temperature

The average soil temperatures as degrees Celsius (°C) and degrees Fahrenheit (°F) are shown in the figure below by treatment zone (i.e., LSZ, UWBZ and Cobble Zone [CZ]). Please note that five temperature monitoring arrays (TMPs 1, 5, 6, 7, 9 and 17) were offline during this operational period, and therefore the temperatures from these wells have been excluded in the average temperature calculations.

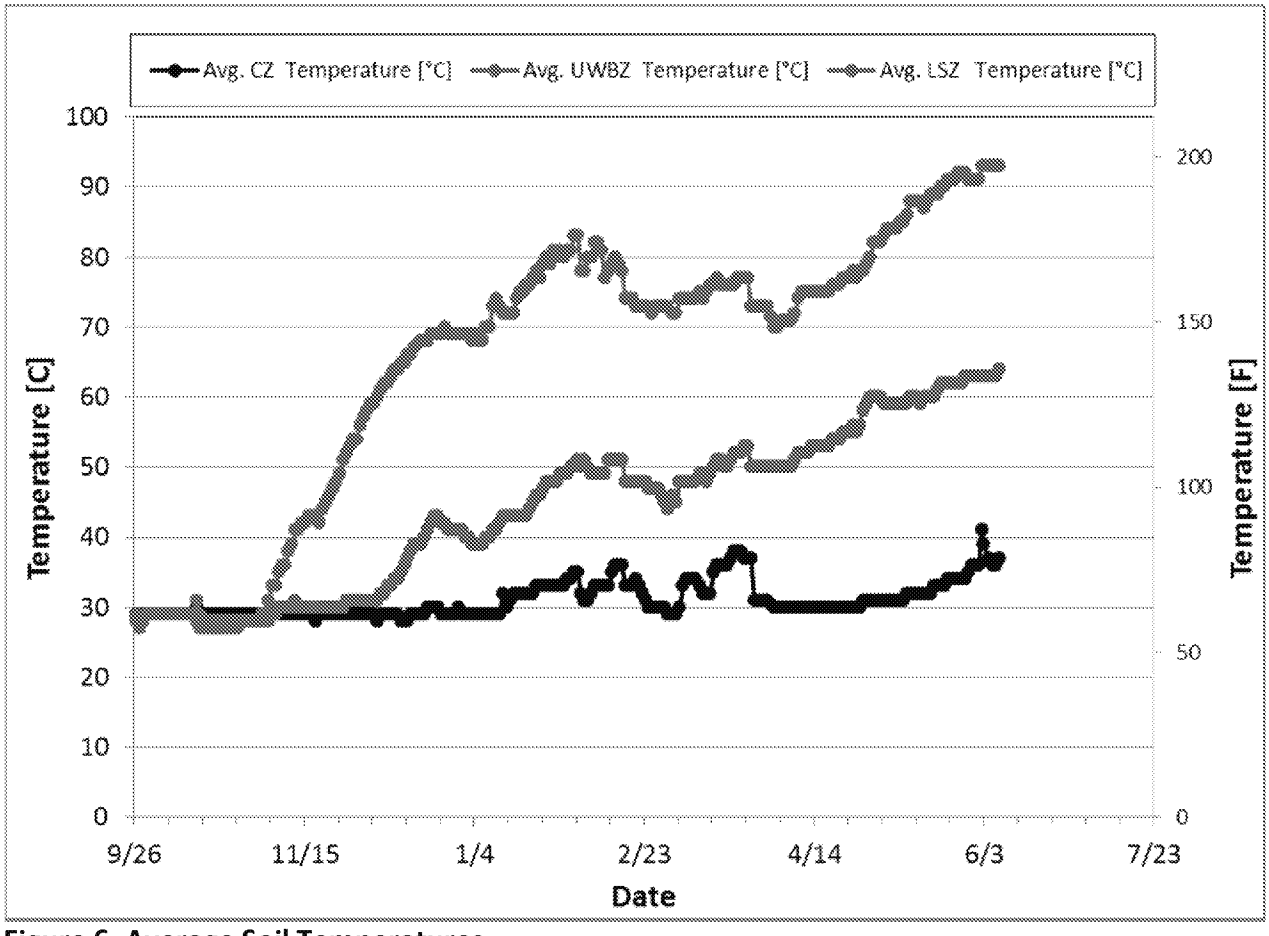

Figure 6. Average Soil Temperatures

Note: The replacement sensor installed in TMP-07 is not reading correctly and therefore the temperature has not been included on this figure. TerraTherm is in the process of troubleshooting this sensor.

8. Vertical and Horizontal Temperature Profiles

The following Figures 7 and 8 show the temperature in °C versus depth profiles for each of the 17 individual temperature monitoring points. Figures 9-12 show the horizontal temperature distribution across the site in four depth intervals.

Temperature highlights for the past week include:

- The heat up rate at perimeter well TMP 2 at 215 ft bgs is now at 60°C. The rest of the sensors are below 36°C.
- TMP 4 is maintaining steam temperatures in the 210–225 ft bgs depth, but has lost temperature in the 235 to 242 ft bgs depth.
- TMP 10 shows steam temperatures in the 215 to 230 ft bgs interval.
- TMP11 has increased to 103°C at 170 ft bgs.

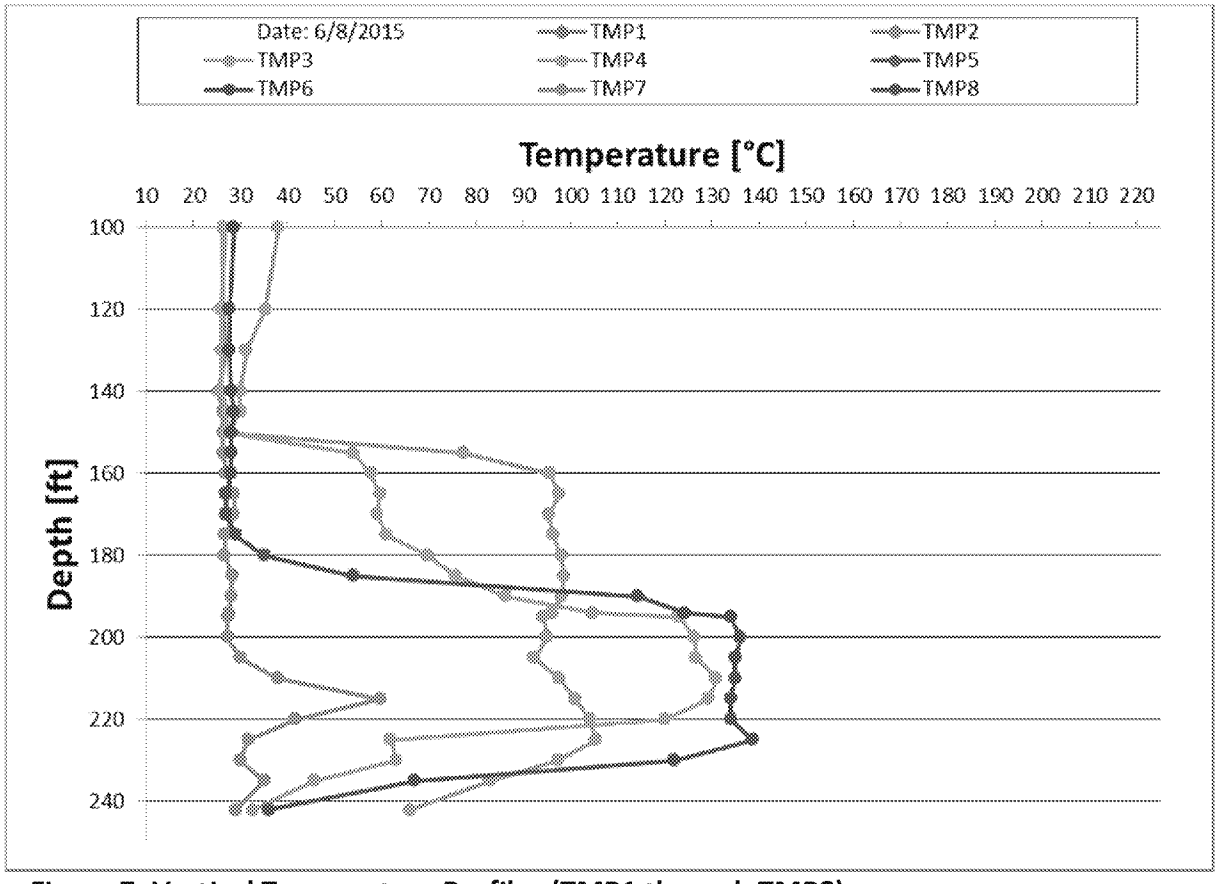

Figure 7. Vertical Temperature Profiles (TMP1 through TMP8)

Note: The replacement sensor installed in TMP-07 is not reading correctly and therefore the temperature has not been included on this figure. TerraTherm is in the process of troubleshooting this sensor.

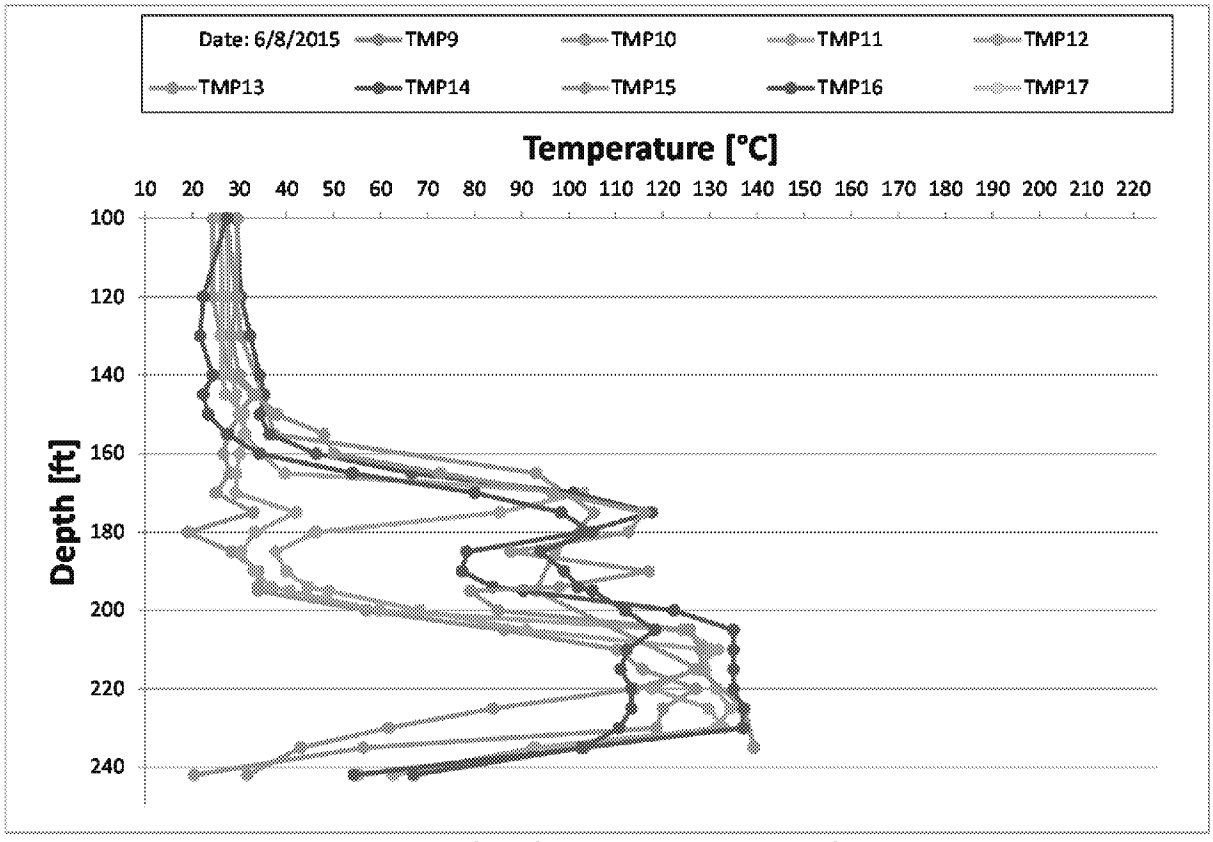

Figure 8. Vertical Temperature Profiles (TMP9 through TMP17)

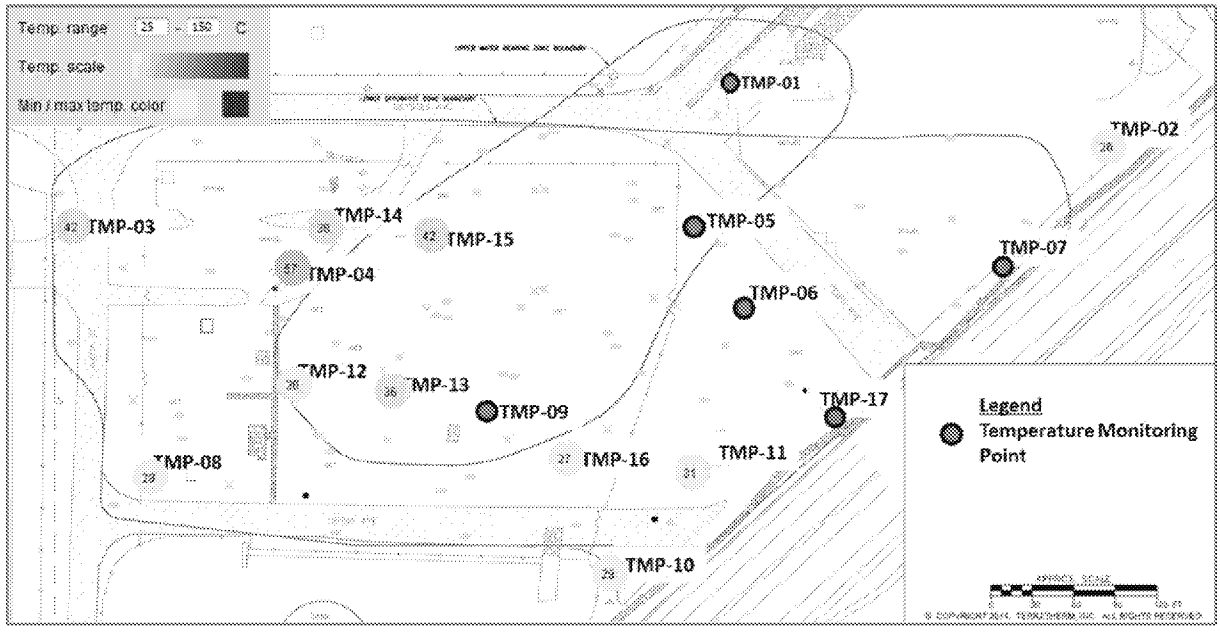

Figure 9. Horizontal Temperature Distribution across the CZ (145-160 ft bgs) (temperatures shown in °C)

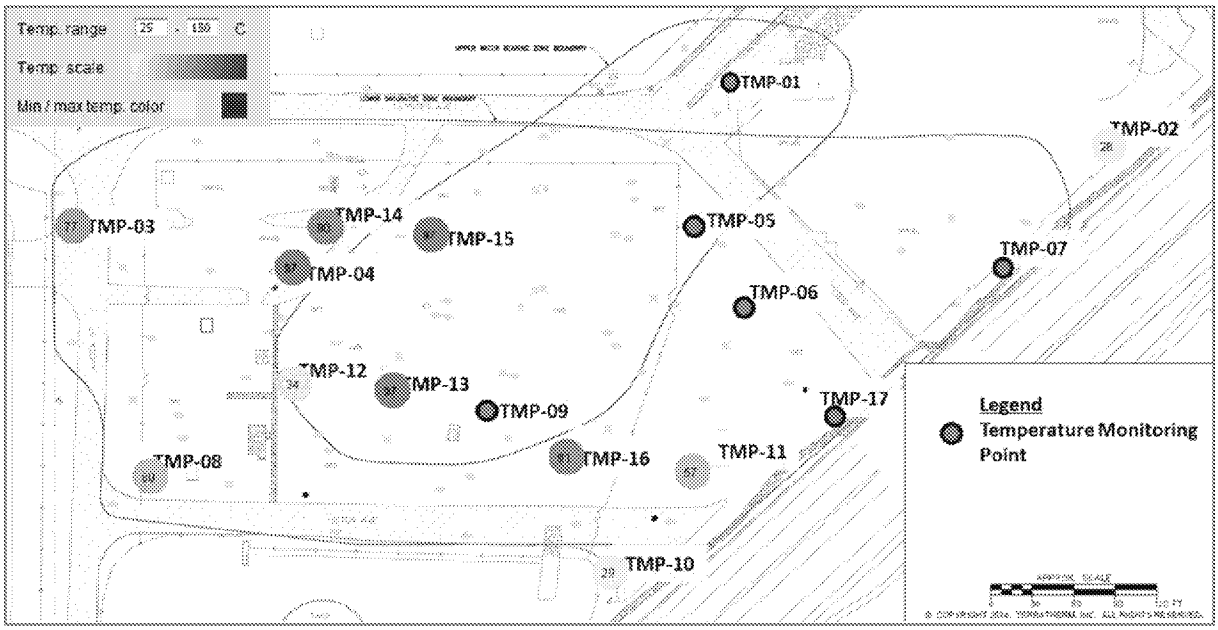

Figure 10. Horizontal Temperature Distribution across the UWBZ (161-195 ft bgs) (temperatures shown in °C)

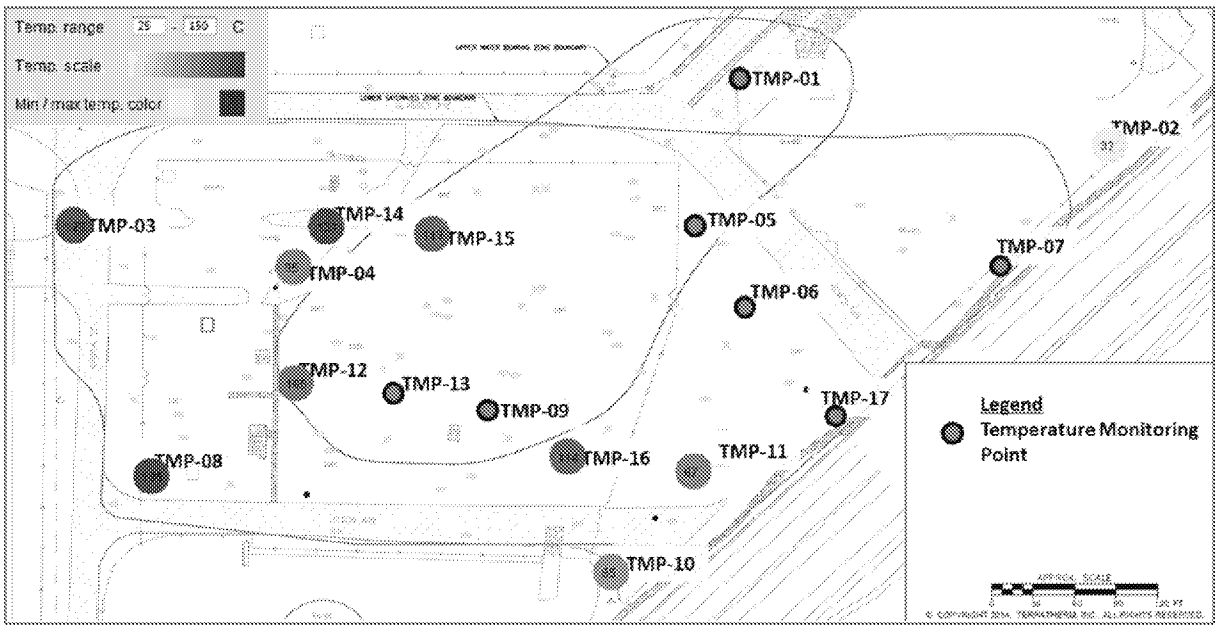

Figure 11. Horizontal Temperature Distribution across the Lower Permeable Zone (196-210 ft bgs) (temperatures shown in °C)

Note: The replacement sensor installed in TMP-13 within the LPZ zone is not reading correctly and therefore the temperature has not been included on this figure.

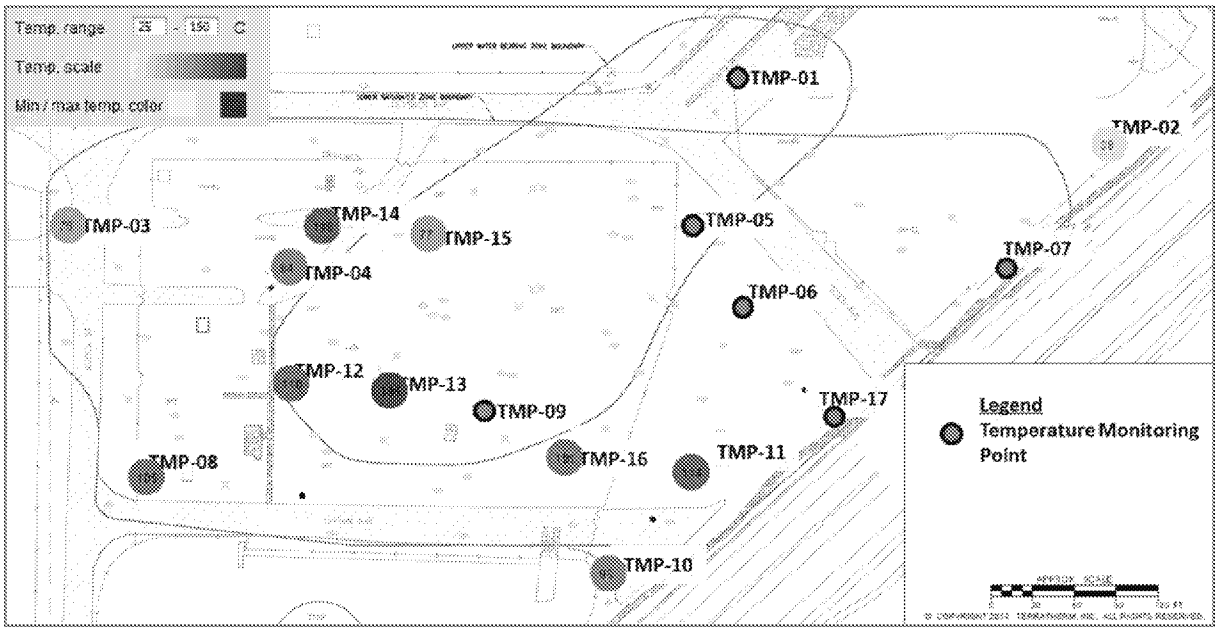

Figure 12. Horizontal Temperature Distribution across the LSZ (211-245 ft bgs) (temperatures shown in °C)

Figure 13 below shows the observed temperatures by depth at selected LSZ extraction wells.

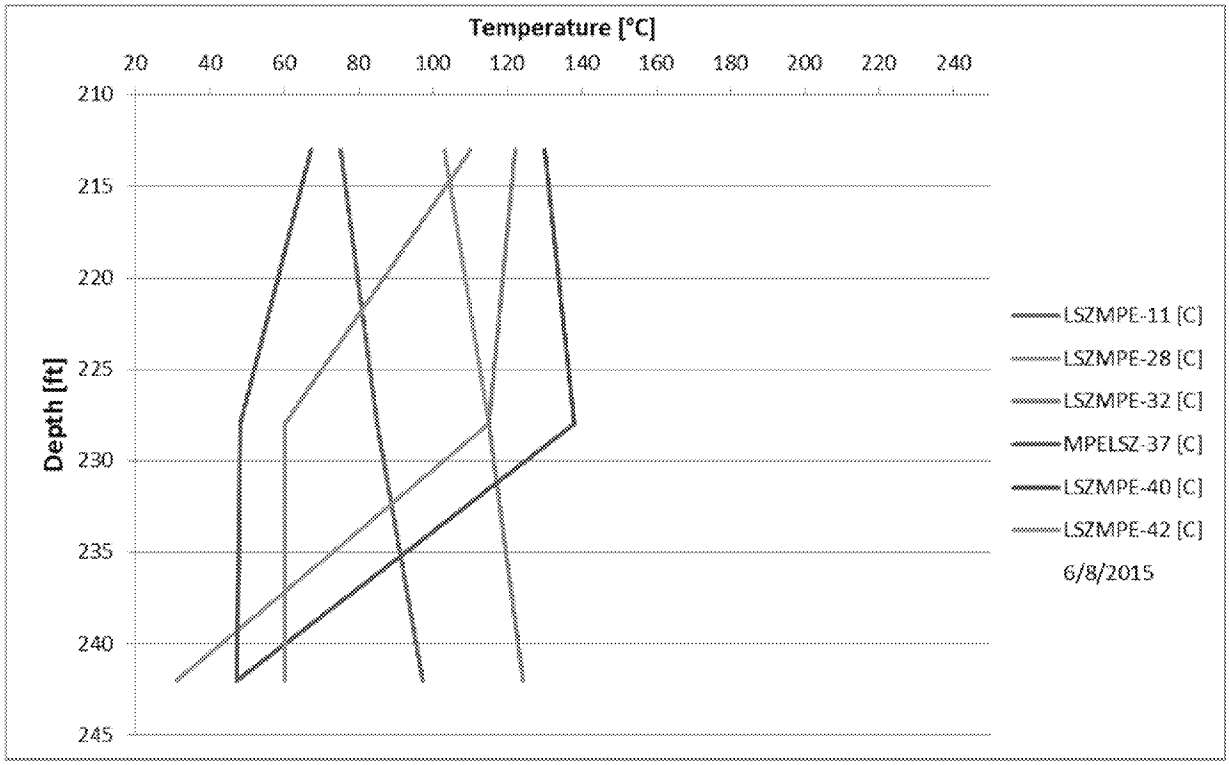

Figure 13. Temperatures by Depth at Selected LSZ Extraction Wells (211-245 ft bgs) (temperatures shown in °C)

9. Cumulative Steam Injection

Steam injection was initiated Thursday, October 16, 2014. Figure 14 below shows the cumulative steam injection for each of the three injection zones.

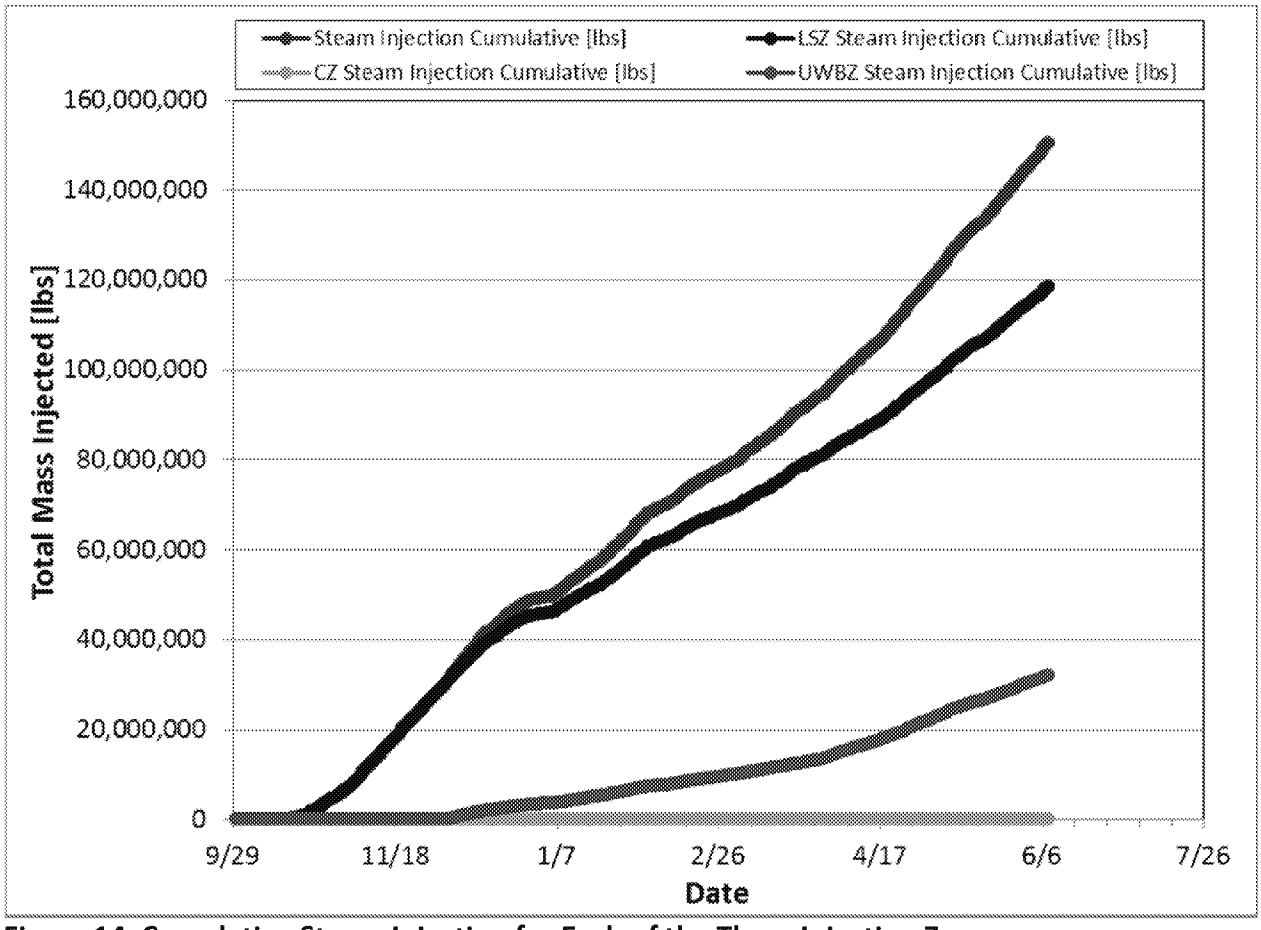

Figure 14. Cumulative Steam Injection for Each of the Three Injection Zones

Note: The steam injection has not yet been initiated in the CZ.

10. Steam Injection Rates

The figure below shows the steam injection rates for each of the three injection zones.

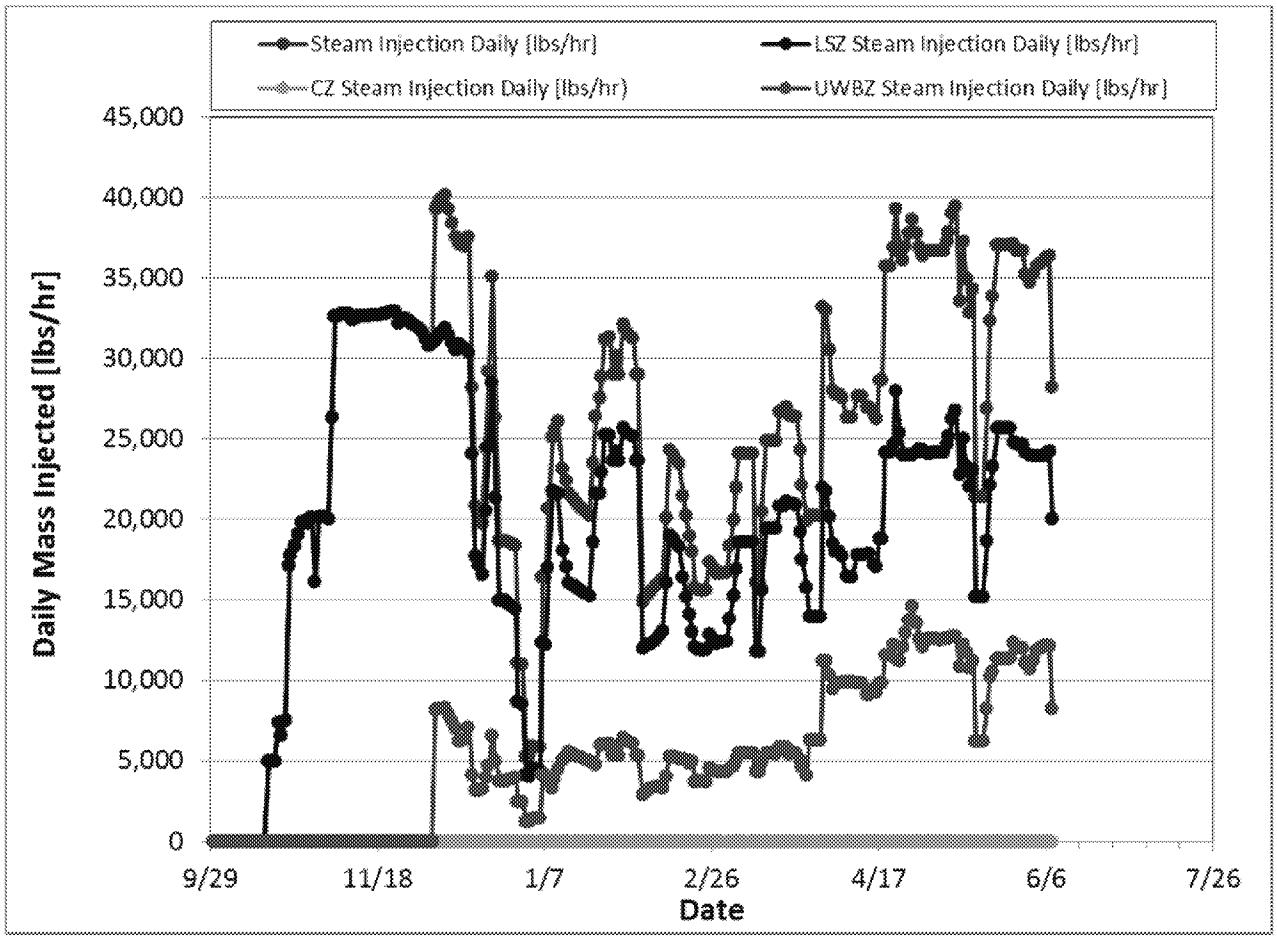

Figure 15. Steam Injection Rate for Each of the Three Injection Zones

Note: The steam injection has not yet been initiated in the CZ.

11. Cumulative Water Extraction by Zone

The cumulative water extraction for each of the three treatment zones is shown below. The cumulative water extraction is calculated based on flow meters installed at each of the 57 extraction wells (accuracy should be considered +/- 20%). The figure below shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

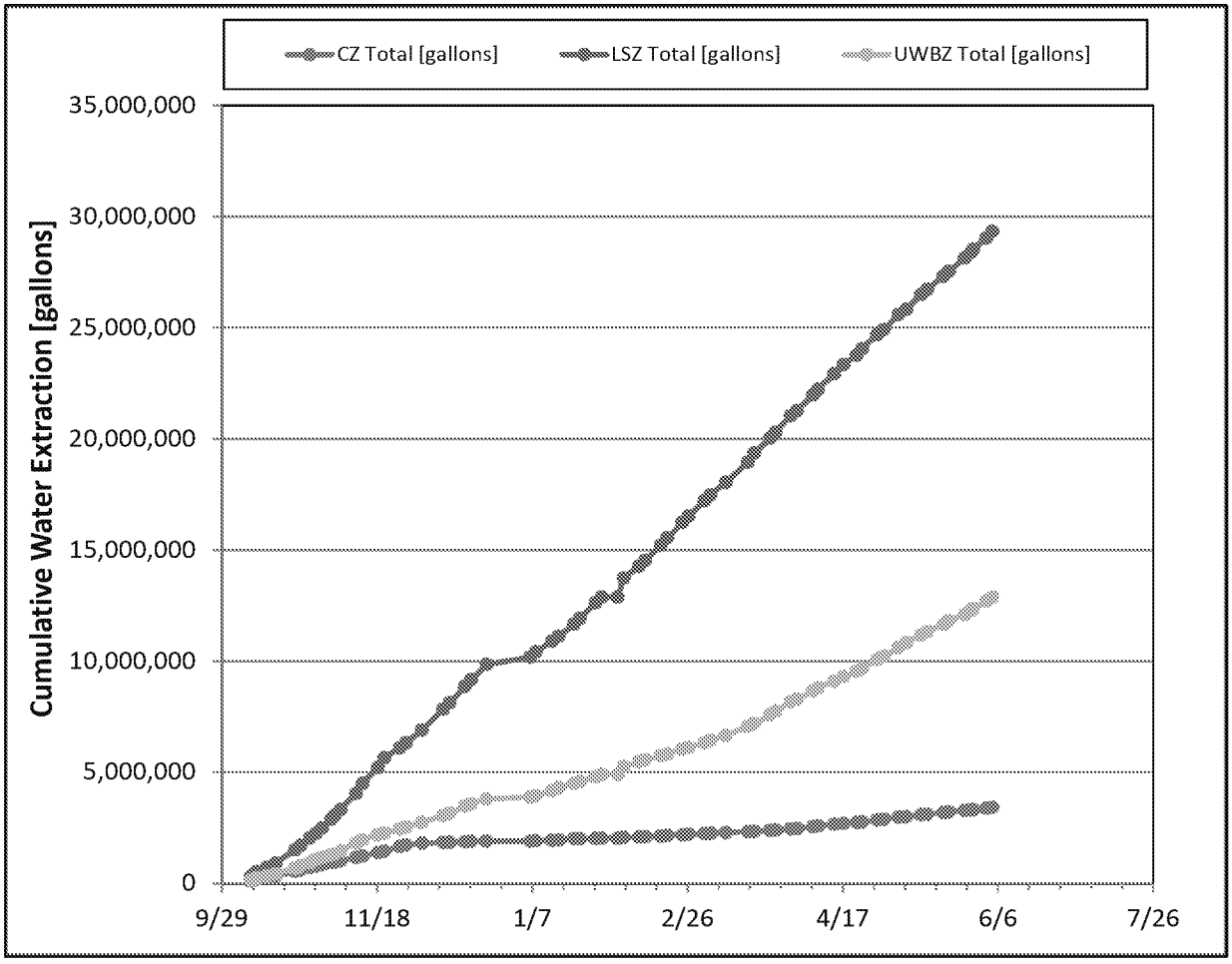

Figure 16. Cumulative Water Extraction for Each of the Three Treatment Zones

12. Water Extraction Rates by Zone

The figure below shows the water extraction rates for each of the three treatment zones.

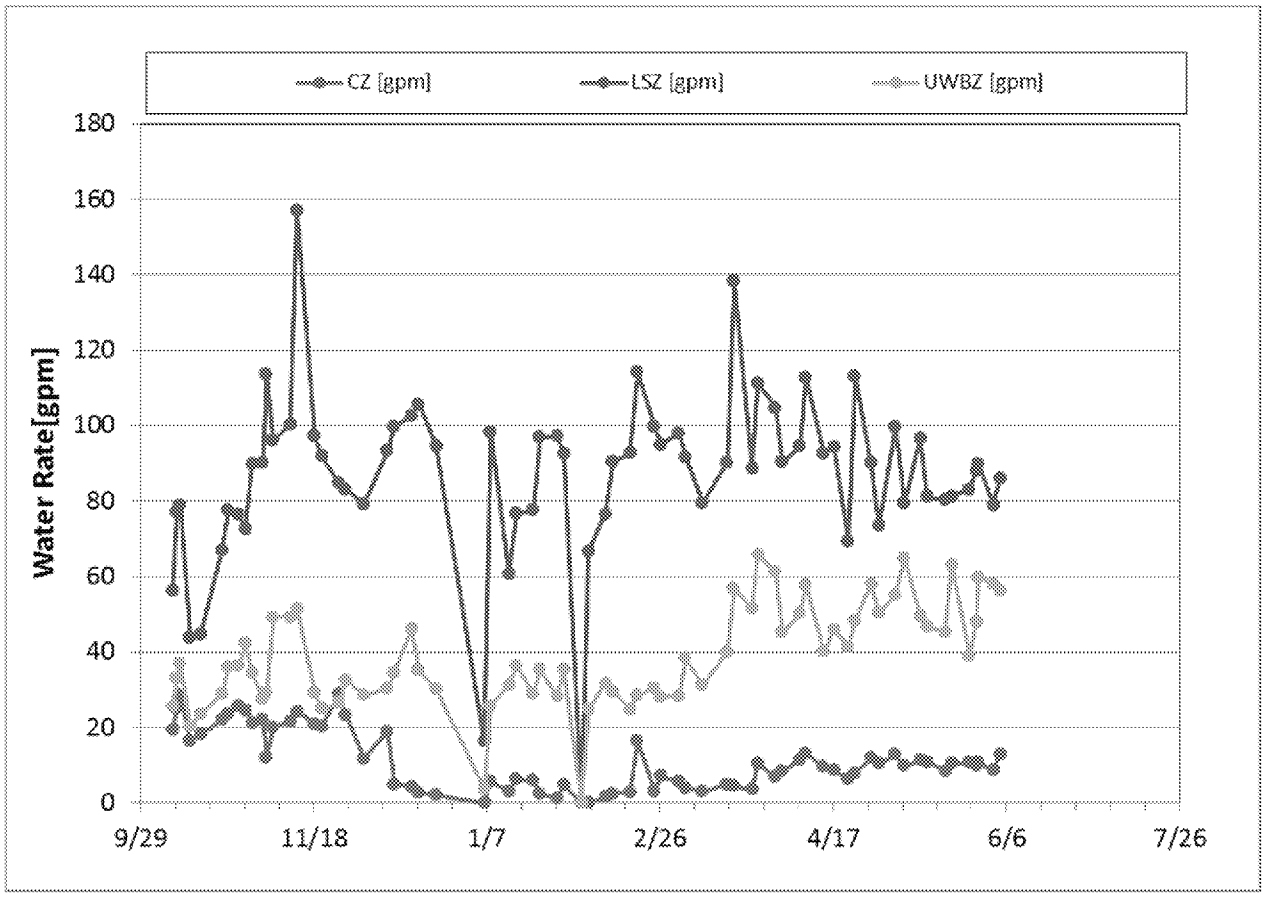

Figure 17. Water Extraction Rates for Each of the Three Treatment Zones

13. Cumulative Water Balance

The cumulative water balance for the site is shown below. The chart shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

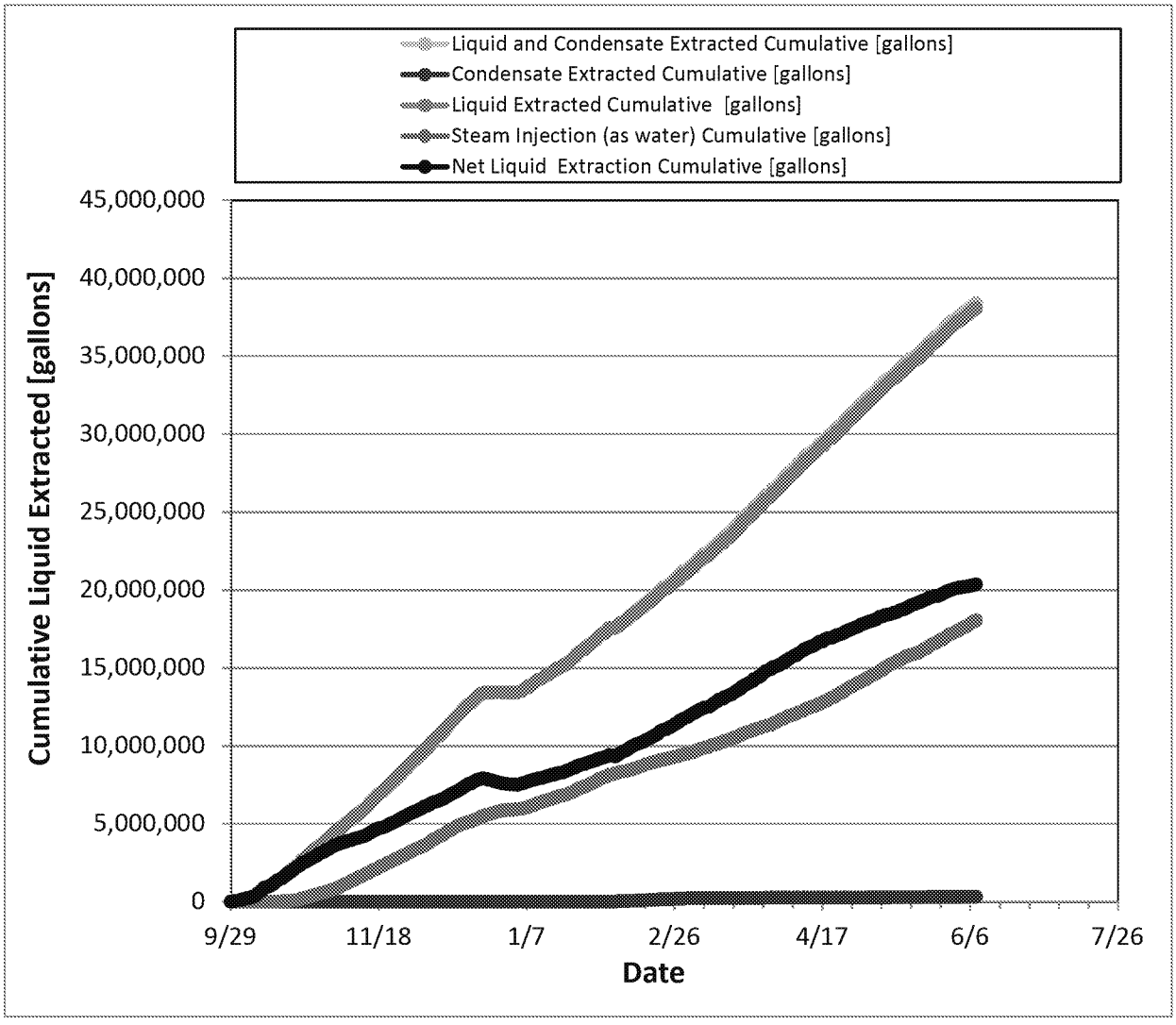

Figure 18. Cumulative Water Balance

14. Water Balance Rate

The total system water extraction rates are shown in the figure below.

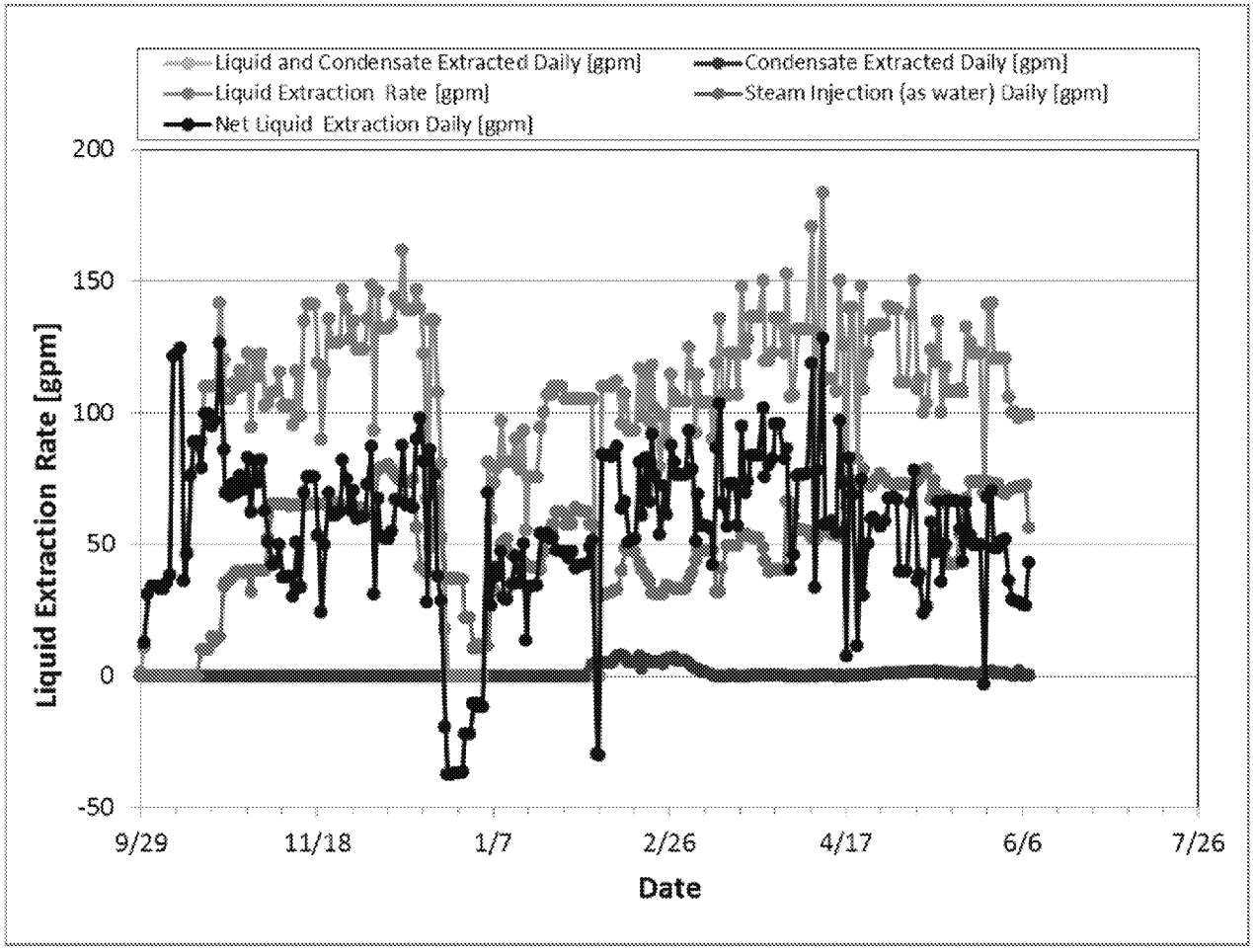

Figure 19. Water Balance Rates

15. Cumulative Energy Balance

The cumulative energy balance for the site is shown below. As shown below, the temperature of the extracted wellfield water (combined motive and formation water) is increasing and energy is starting to be extracted from the subsurface.

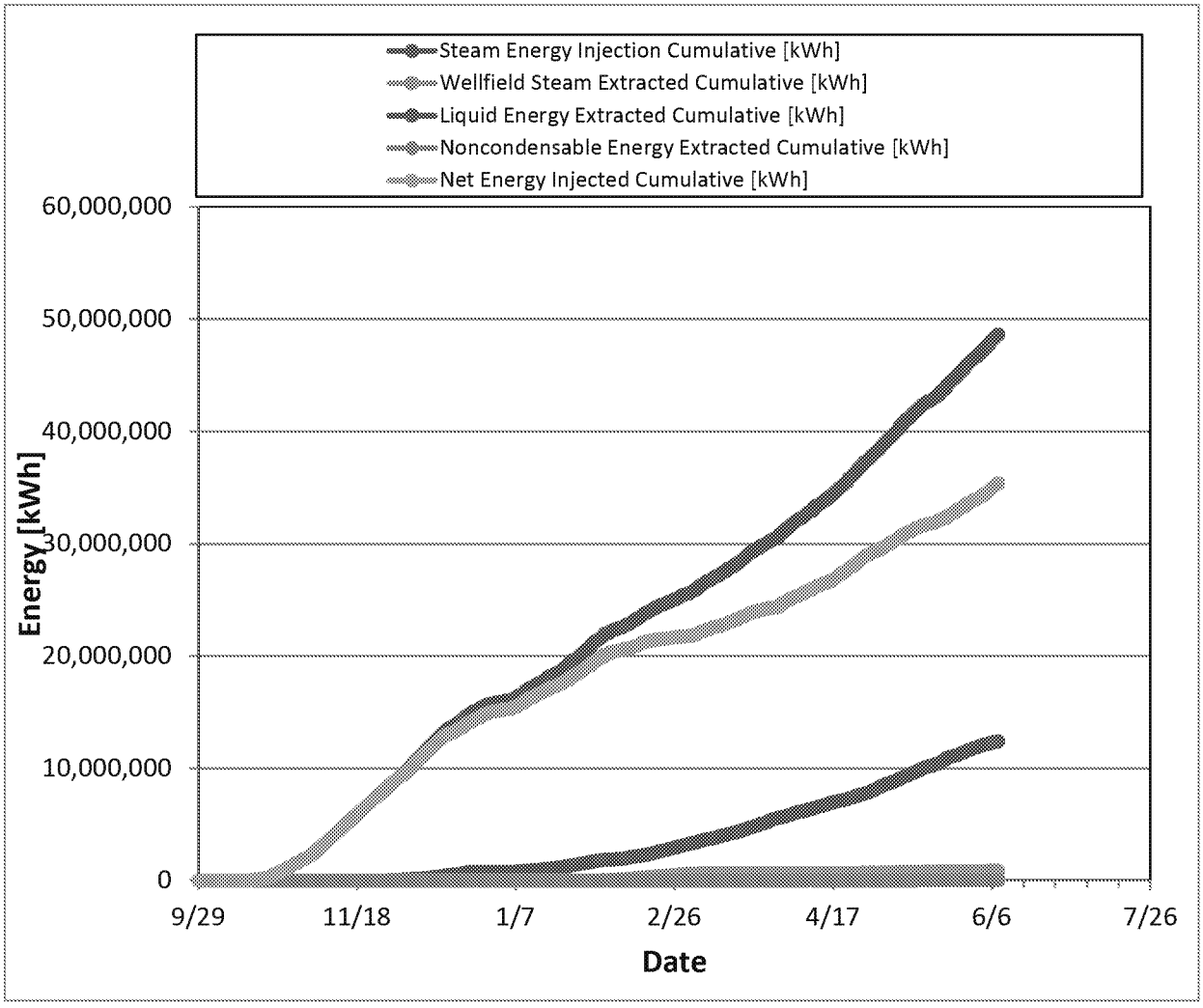

Figure 20. Cumulative Energy Balance

16. Energy Balance Rates

The energy balance rates are shown below.

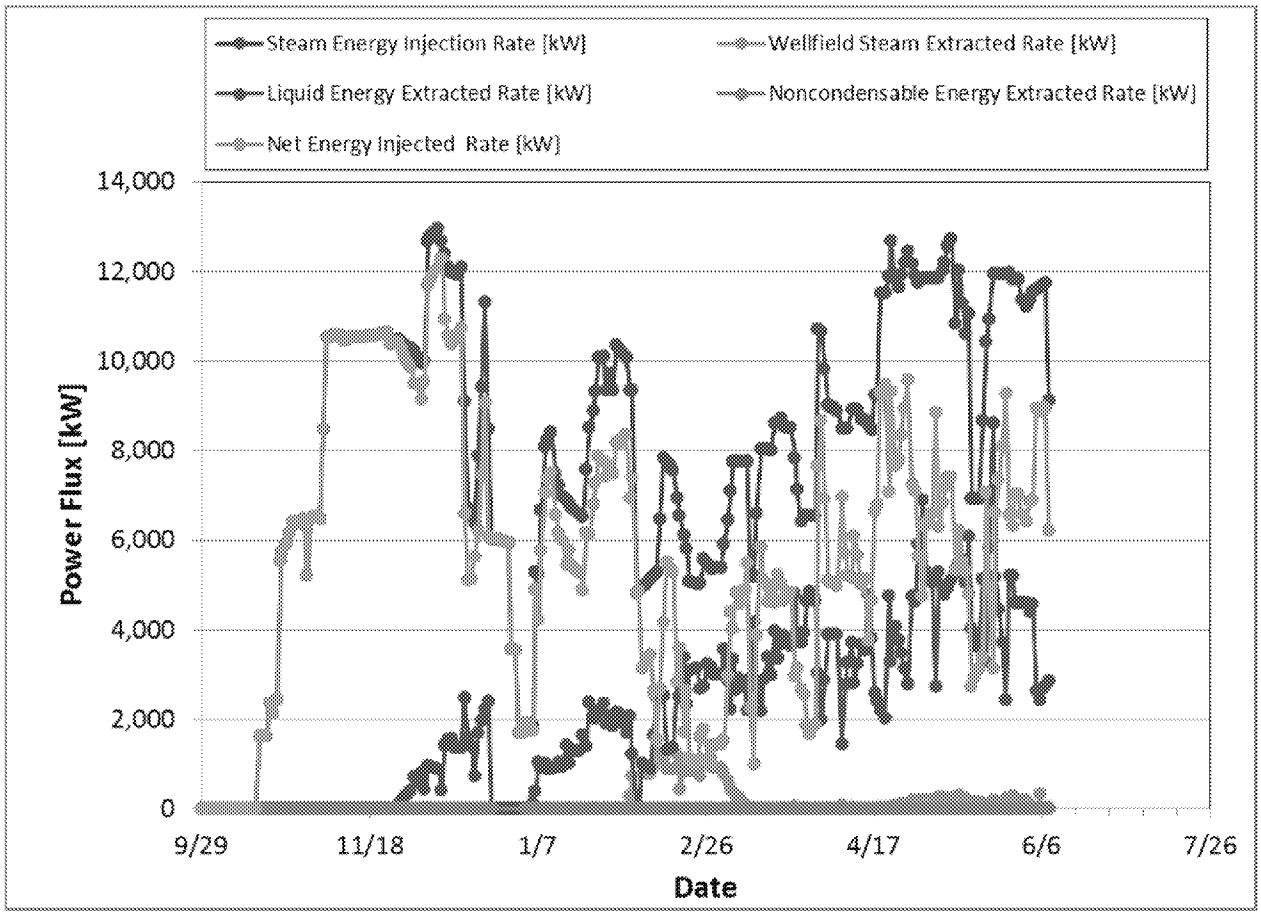

Figure 21. Energy Balance Rates

Note: At this time only limited energy has been extracted as steam from the site based on the condensate generated.

17. Perimeter Water Level Data

Table 2 below presents the change in perimeter groundwater elevations since SEE system startup. The readings collected on September 24, 2014 (not shown) represent baseline conditions. A negative number shows that the groundwater elevation is lower than the baseline elevation, thus indicating an inward hydraulic gradient into the treatment zone. Liquid extraction began on September 29, 2014. Perimeter water level data are collected on a weekly basis. The regional groundwater table at the Site is increasing at a rate of approximately 1.5 ft/year; thus, each measured value shown in Table 2 has been corrected to take the regional changes into account.

Table 2. Perimeter Groundwater Elevation Changes

	5/8/2015		5/15/2015		5/22/2015		5/29/2015		6/5/2015	
Monitoring Well	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells										
ST012-C01	-0.43	-0.17	-0.24	0.22	-0.33	-0.07	-0.31	0.05	-0.36	-0.02
ST012-C02	-0.47	-0.11	-0.39	0.11	-0.46	-0.04	-0.35	0.14	-0.40	-0.03
UWBZ Wells										
ST012-RB-3A	-0.28	-0.29	-1.80	-1.49	-0.95	0.88	-0.11	0.87	-0.05	0.08
ST012-U02	0.10	-0.35	0.02	-0.05	-0.17	-0.16	0.39	0.59	0.25	-0.12
ST012-U11	-0.52	-0.25	-0.73	-0.18	-1.08	-0.32	-0.13	0.98	0.15	0.30
ST012-U12	-0.28	-0.35	-0.70	-0.39	-1.08	-0.35	0.15	1.26	0.27	0.14
ST012-U37	-0.21	-0.23	-1.81	-1.57	-0.96	0.88	-0.01	0.98	0.09	0.12
ST012-U38	-0.17	-0.23	-0.25	-0.05	-0.59	-0.31	-0.16	0.46	-0.08	0.10
LSZ Wells										
ST012-W11	-1.60	-0.48	-0.70	-0.03	-0.70	0.60	-0.70	0.52	0.30	0.05
ST012-W12	-1.74	-0.97	-1.20	0.57	-0.81	0.42	-0.36	0.48	-0.36	0.02
ST012-W24	-1.22	-0.52	-2.01	-0.76	-0.75	1.29	-0.73	0.05	-0.48	0.27
ST012-W30	-0.23	-0.57	-0.23	0.03	-0.13	0.12	0.80	0.97	2.15	1.37
ST012-W34	-0.75	-0.58	-0.62	0.16	-0.50	0.15	-0.05	0.48	-0.11	-0.04
ST012-W36	-0.71	-1.56	N/A	N/A	0.28	1.05	0.86	0.61	0.75	-0.09
ST012-W37	-1.85	-0.56	-1.41	0.47	-1.09	0.36	-0.72	0.39	-0.74	0.01
ST012-W38	-0.71	-0.45	-0.71	0.03	-0.58	0.16	-0.11	0.50	-0.15	-0.02

Figure 22 shows the manually collected groundwater elevation trends since system startup. Additionally Figure 23 shows the groundwater elevations continuously logged in selected perimeter wells equipped with transducers. The regional groundwater table correction has also been applied to Figure 22 below.

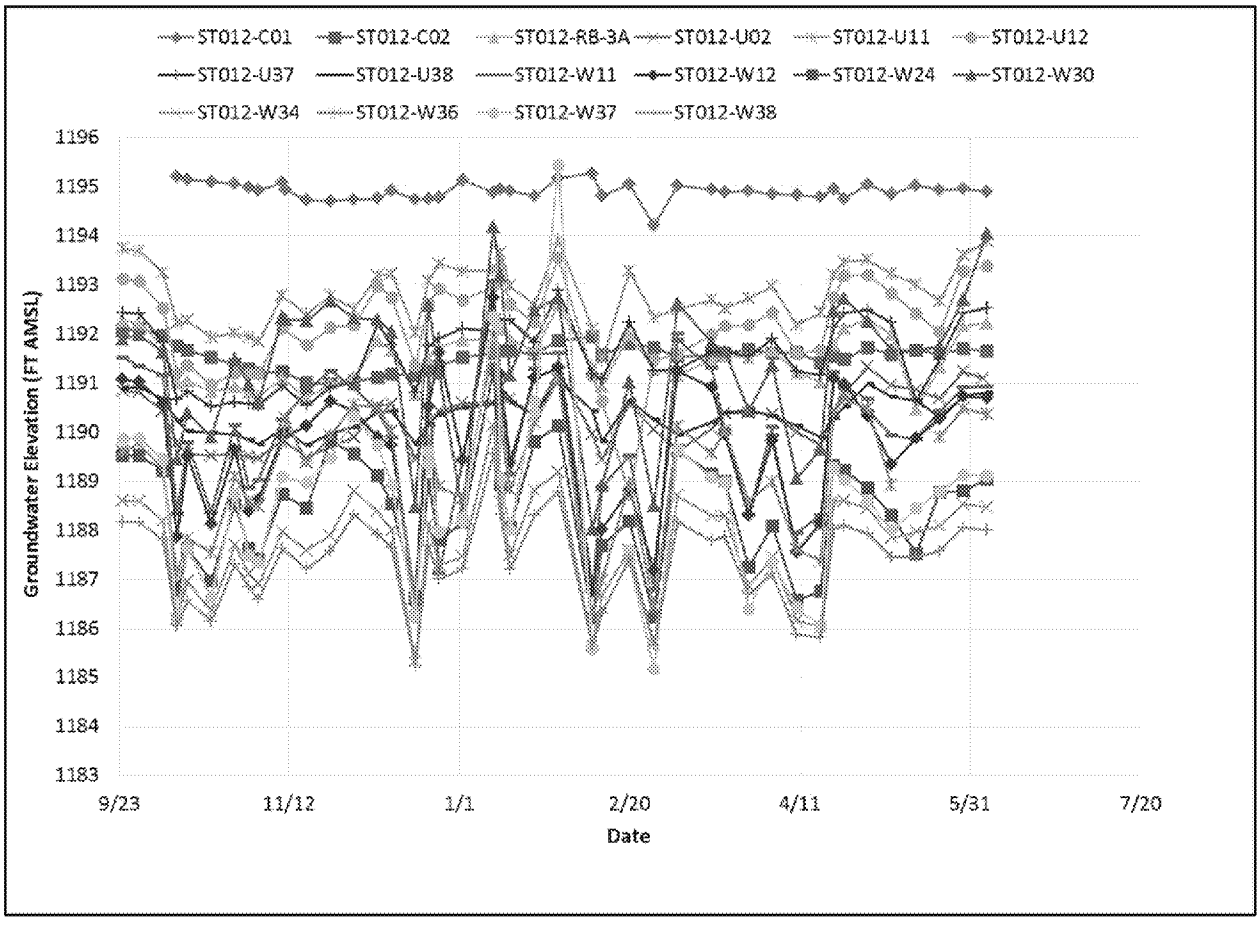

Figure 22. Manually Collected Perimeter Groundwater Elevations

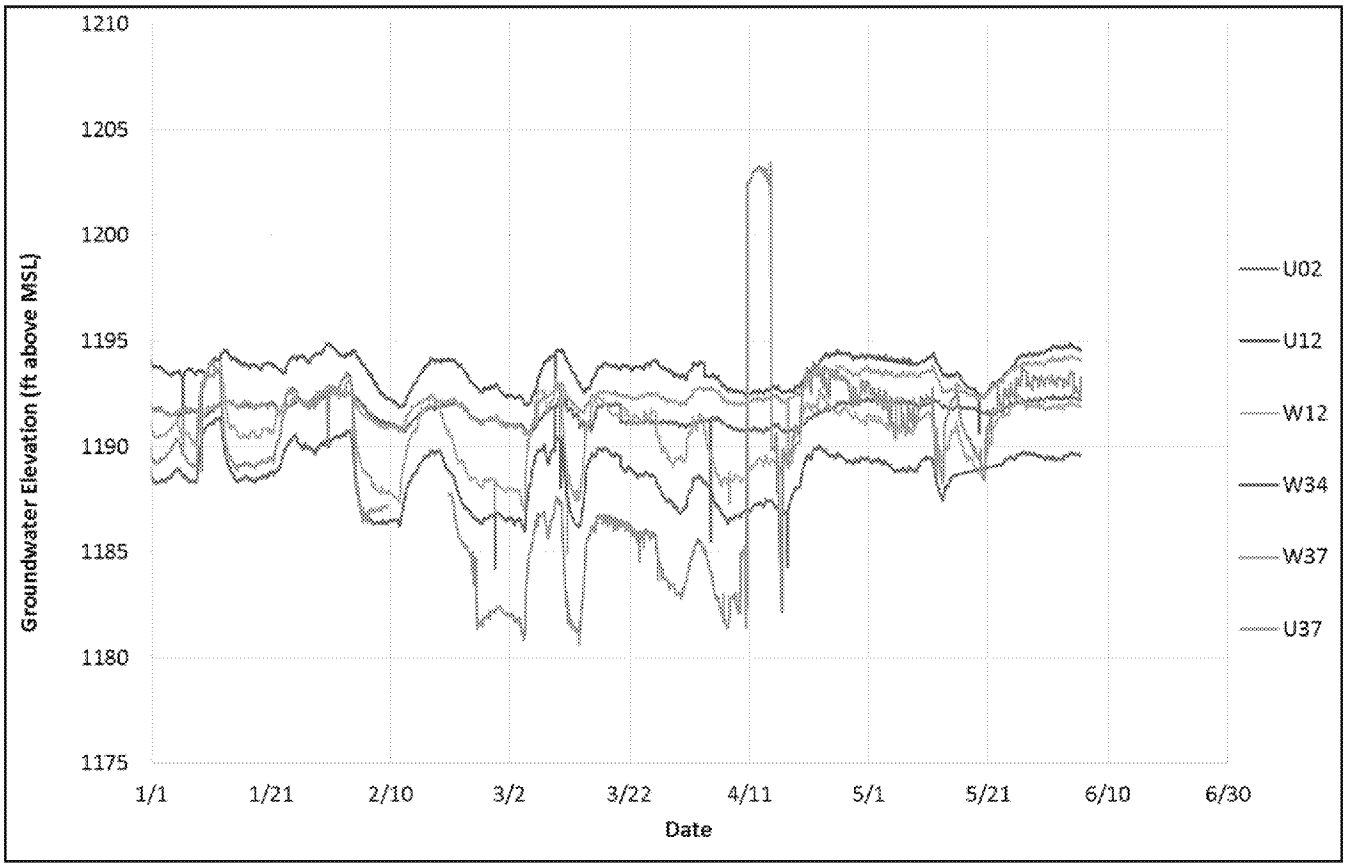

Figure 23. Automatically Collected Perimeter Groundwater Elevations

Table 3 below presents the measured LNAPL thicknesses of the perimeter wells at the site. The readings collected on September 24, 2014 represent baseline conditions while the readings collected after are during SEE operations. Perimeter LNAPL thickness data are collected on a weekly basis.

Table 3. Perimeter LNAPL Thicknesses (ft)

Monitoring Well	5/22/2015		5/29/2015		6/5/2015	
CZ/UWBZ Wells	Before Bailing	After Bailing	Before bailing	After Bailing	Before Bailing	After Bailing
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells						
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells						
ST012-W11	84.60	0.63	96.23	0.00	45.06	0.00
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	0.00	0.00	0.35	0.35	0.00	0.00
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	22.83	6.01	43.82	6.52	51.00	6.52
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00

On December 1, 2014, temperatures at selected perimeter wells were added to the monitoring program. Figure 24 below shows the manually collected temperatures recorded at the wells included in the monitoring program. Additionally Figure 25 shows the temperatures continuously logged in selected perimeter wells equipped with transducers.

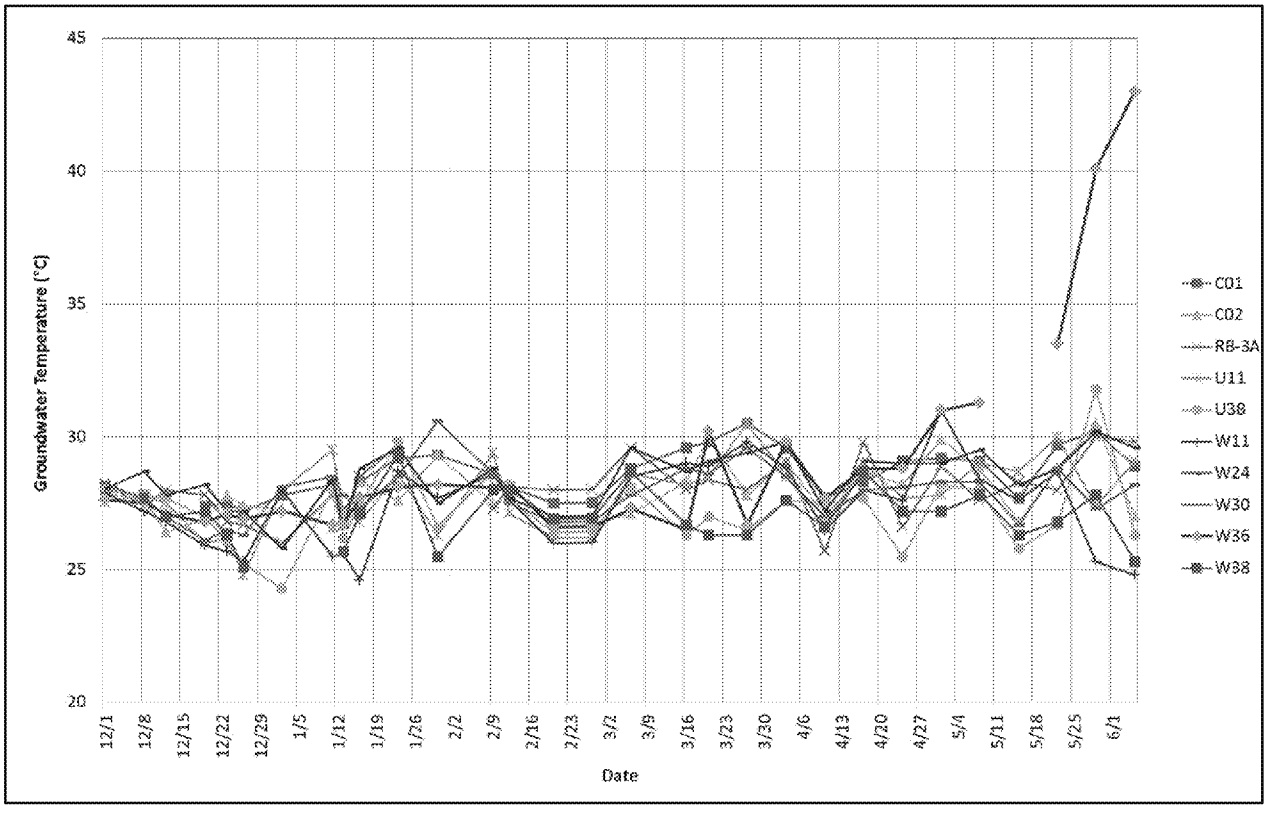

Figure 24. Manually Collected Perimeter Well Groundwater Temperatures

Note: The temperatures measured at W36 are collected from the UWBZ interval (165 ft bgs). W36 is installed close to the cell phone lot where perimeter UWBZ steam injection wells are located. On May 30, 2015 steam injection in that area was reduced by decreasing steam injection to wells UWBZ09, UWBZ12, and UWBZ25. This is also the area of the treatment zone where pressure cycling was initiated on June 8, 2015.

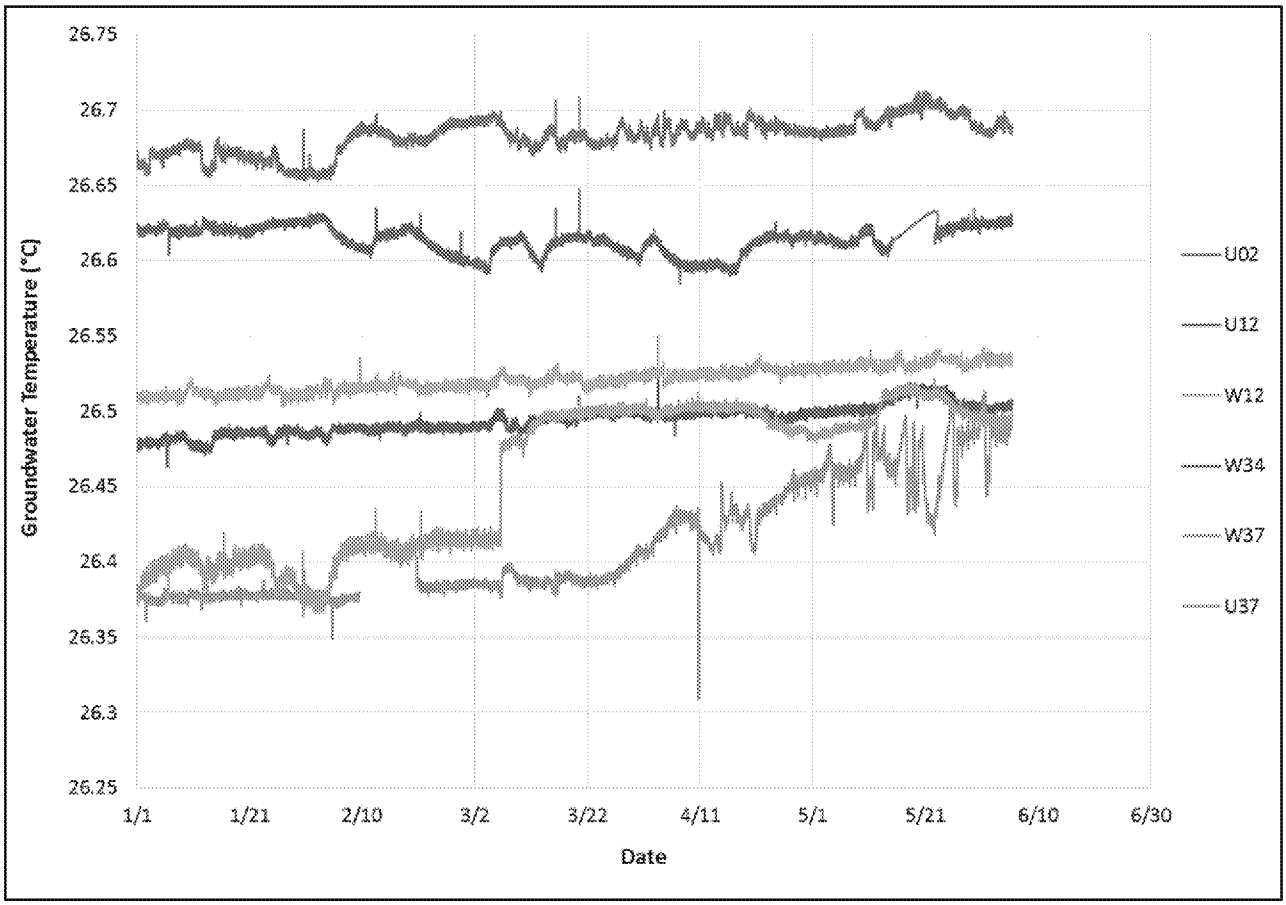

Figure 25. Automatically Collected Perimeter Well Groundwater Temperatures

Note: On March 7, 2015 operational personnel replaced the U37 logger unit. The increase in temperature on March 7, 2015 at U37 is a result of this replacement.

18. Natural Gas Usage

The following figure shows the natural gas usage rate in cubic feet per hour (cf/hr) and cumulative natural gas use in cubic feet (cf) to date at the site.

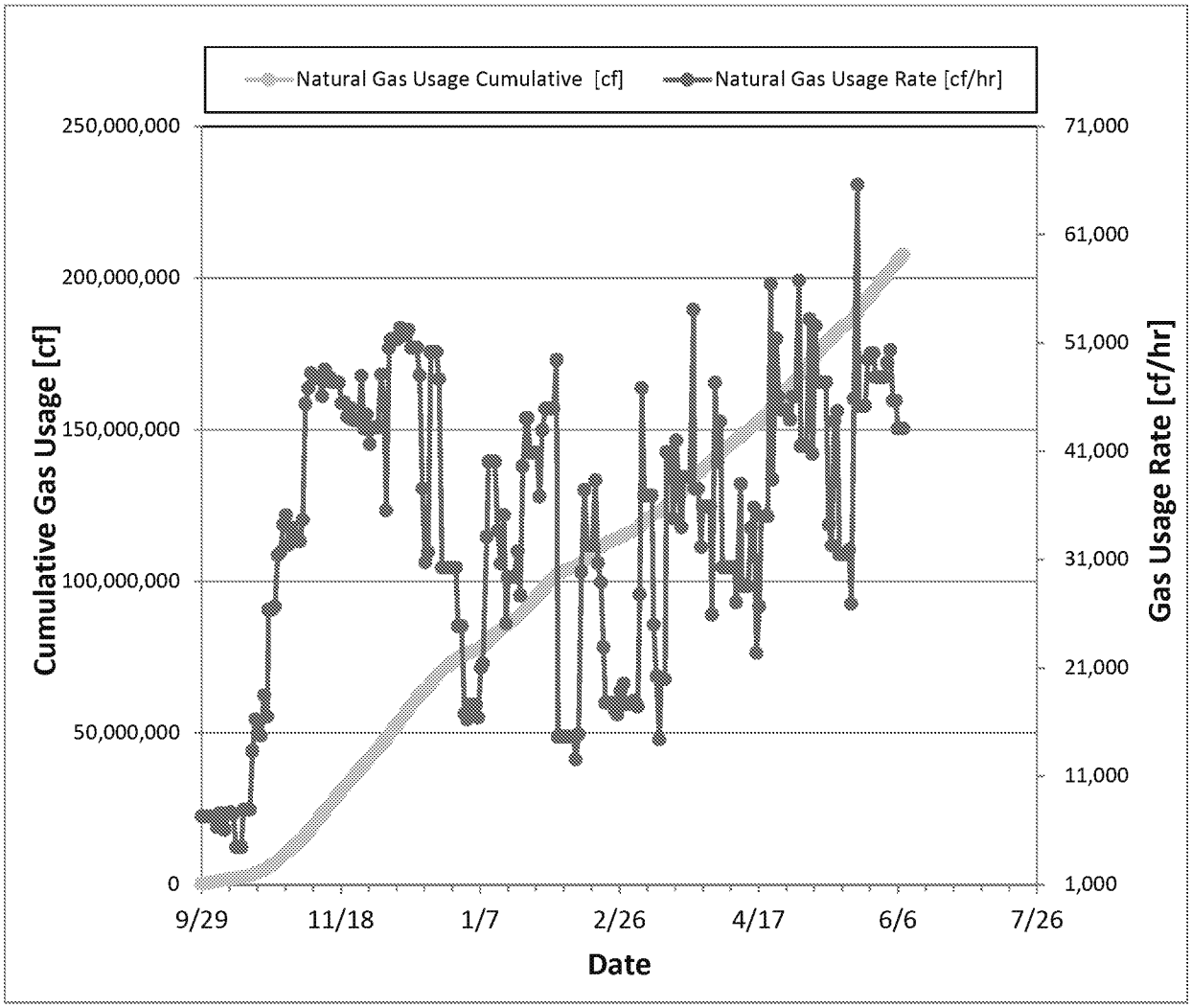

Figure 26. Natural Gas Usage

19. Waste Generation

On January 19, 2015 a total of 8,033 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 2,857 gallons or 18,800 lbs.

On February 18 and 19, 2015 a total of 24,430 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 3,645 gallons or 23,984 lbs.

On March 12, 2015 a total of 11,359 gallons of predominantly water from tank cleanout activities was removed from the site by Mesa Oil for recycling. The JP-4 mass in the water was limited.

On March 20, 2015 the first shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On March 30 and 31, 2015 a total of 32,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On April 24, 2015 a shipment of bag filters (three cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On May 29, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

20. NAPL Reuse

On April 7, 2015 a total of 12,647 gallons of stored NAPL was sent to Mesa Oil for reuse. The analysis showed that 703 gallons of the total fluid was water. The water has been subtracted from the NAPL recovery estimate.

On April 21-22, 2015 a total of 13,076 gallons of stored NAPL was sent to Mesa Oil for reuse. Analysis showed a water content between <1% to 3% or a total of 227 gallons of water. The water removed has been subtracted from the NAPL recovery estimate.

On May 7, 2015 a total of 5,722 gallons of stored NAPL was sent to Mesa Oil for reuse.

On May 21, 2015 a total of 1,400 gallons of stored NAPL was sent to Mesa Oil for reuse.